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AREA, PRODUCTION AND PRODUCTIVITY OF VEGETABLES AND ESTIMATION OF VEGETABLE SEED REQUIREMENT

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ABSTRACT

Vegetables are one of the cheapest sources of nutrition and have important role in fighting hunger and nutritional security. The vegetable sector is characterized by verity, not only in terms of the diversity of crops but also in terms of number of countries across the globe. Haveri district of Karnataka is a one of the major vegetable producing district. To study the growth rate of area, production and productivity of tomato, cabbage, green chilli and brinjal crops in Haveri, compound growth rate was used taking the data from 2005-06 to 2015-16. It was observed that all the crops in Haveri district had shown growth in area ranging from 6.46 to 10.78 per cent. Highest growth in area was observed in green chilli and lowest tomato. Similarly, production of selected crops in the district was grown within the range of 5.22 per cent to 13.07 and highest production growth was observed in green chilli. Significant productivity was observed in tomato and cabbage. Overall, production increased due to increase in area, not due to productivity enhancement in the selected vegetables. Projected demand for all the selected vegetables in Haveri district revealed that increasing demand for the next five years and growth rate of demand will be from 1.68 to 5.59 per cent per annum. Highest growth in demand is predicted for green chilli in the district.

KEYWORDS: Growth Rate, Demand Estimation and ARIMA

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Original Article

INTRODUCTION

Vegetable plays a major role in Indian agriculture by providing food, nutritional and economic security and more importantly, providing quick returns per unit area. In addition, vegetable have higher productivity, shorter maturity cycle, high value and provide higher income leading to improved livelihoods. Vegetables are one of the cheapest sources of nutrition and have important role in fighting hunger and nutritional security. The vegetable sector is characterized by verity, not only in terms of the diversity of crops but also in terms of number of countries across the globe. Asia cultivates by far the most number of vegetables in the world and has also shown strongest growth over last decade. Much of this growth can be contributed to China and India owing to productivity improvement by way of use of higher quality imputs (e.g. seeds), technological advances, better management skills and the increased area under poly house production. More than 50 indiginious and exotic vegetables of temperate and tropical origin are native to India. With a production of less than 20 million tone before independence, vegatble production has increased many fold to 212.89 million tons from an area of 9.39 million hectares during 2014-15. Varied agro-climatic conditions in India make it possible to grow a wide variety of vegetable crops in all the seasons of the year in one part of the country or another. India can claim to grow the largest number of vegetable crops compared to any other countries in the world.

Objective of the Paper

- Study the growth rate of area, production and productivity of tomato and cabbage
- Estimate the seed requirement for the future years

METHODOLOGY

Nature and Sources of the Data

Hveri district of Karnataka was taken for the study. The data pertaining to area production and productivity was taken from the period of 2005-06 to 2015-16 were analyzed for better understanding of growth.

Analytical Tools and Techniques Employed

For the purpose of analyzing data to meet the objectives of the study, the following statistical techniques were used.

- **Growth Rate Analysis**

In order to assess the growth in area, production and yield of chilli and replacing crop cotton, ten years data from 2001/02 to 2009/10 were used. The compound growth rates were computed by using the exponential function of the form.

$$Y_t = AB^t U_t \quad (1)$$

Where, Y_t = Area, production and productivity of chilli and cotton

t = Year 1,2.....n

U_t = Distribance term in year "t"

"a" and "b" are the parameters to be estimated

The equation (1) was transformed into log linear form and written as

$$\text{Log } Y = \log A + t \log B + \log U_t \quad (2)$$

Equation (2) was estimated by using ordinary least squares (OLS) technique.

Compound growth rate (g) was then estimated by using the relationship given in equation (3).

$$\hat{g} = (b-1) * 100 \quad (3)$$

Where, $\hat{g}$ = Estimated compound growth rate % per annum

$\hat{b}$ = Antilog of B

The standard error of the growth rate was estimated and tested for its significance with 't' statistics.

- **Auto Regressive Integrated Moving Average (ARIMA) Model**

Forecasting of demand for selected vegetable seeds in Haveri district, the demand data of vegetable seeds were required. And it was very difficult to get data on demand for the vegetable seeds in the previous years. There for under vegetable crop in each of the Haveri district where collected for the past 10 years (2005-06 to 2015-16).

The area data where multiplied by seed rate to arrive at the total seed requirement (demand) in previous 10 years. This data where use to for forecast the demand in each of the district for the next 5 years.

The present study adopted Autoregressive Integrated Moving Average (ARIMA) method to forecast vegetable seeds requirement in Haveri district with the help of SPSS software. The class of ARIMA models, also called Box-Jenkins models, is suitable for non-stationary time series data, as is the case for many economic time series, where one part of the series behaves much like any other series. ARIMA models consist of two parts, an autoregressive (AR) part and a moving average (MA) part. If the series Y_t consists of characteristics of both AR and MA, it follows an ARMA *(p,q)* process where there are p autoregressive and q moving average terms. The term integrated (I) in ARIMA is included because of the differencing process (d) that can be reversed (meaning integration process) to obtain the original series during estimation process. Thus, if a series Y_t has to be differenced d times to make it stationary and then apply ARMA(p,q) model to it, it is generally said that the original time series is ARIMA(p,d,q) model where *p, d*, and q are integers with values greater than or equal to zero and d, denotes the number of times the series has to be differenced before it becomes stationary and p and q are as defined earlier

The mathematical representation of AR, MA and ARIMA processes is provided in detail in literature. For non-seasonal time series, the simplified general form of these processes is given as;

- The p^{th}-order autoregressive model, AR(p) has the general form as;

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + \varepsilon_t$$

Where:

Y_t = the dependent variable (*i.e.* maize price) at time *t*.

$Y_{t-1}, Y_{t-2}, \ldots Y_{t-p}$ = dependent variable at time lags *t-1, t-2* and *t-p,* respectively.

$\phi_0, \phi_1, \phi_2, \ldots \phi_p$ = coefficients to be estimated

ε_t = error term at time *t*

- The autoregressive moving average, MA (q) which has the general form as;

$$Y_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q}$$

Where:

Y_t = dependent variable at time t

μ = constant mean of the process

ε_t = error term at time *t*

$\theta_1, \theta_2, \ldots \theta_q$ = coefficients to be estimated

$\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots \varepsilon_{t-q}$ = errors in the previous time periods that are incorporated in the dependent variable Y_t.

- Autoregressive Moving Average model: ARIMA (p,q) which is a combination of AR (p) and MA (q) processes and has the general form as;

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + .. + \phi_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q}$$

The Box-Jenkins (BJ) Methodology

ARIMA technique is also popularly known as Box-Jenkins method. This method consists of four steps which are well explained in many econometrics as well as time series analysis literature. In this study the description of the four steps for model building as adopted (a) Identification of model, (b) Estimation of parameters, (c) Diagnostic checking and (d) Forecasting, are described in detail below.

- **Identification of Model**

This step refers to the process of finding out the appropriate values of *p, d* and *q*. The main statistical tools used for identification of model are the Auto-Correlation Function (ACF), the Partial Auto-Correlation Function (PACF) and the resulting correlograms, which are simply the plots of ACF and PACFs against the lag length have provided some theoretical hints to consider while examining the ACF and PACF correlogram in order to identify appropriate model, AR(*p*) or MA(*q*) or ARMA (*p,q*).

First, the ACF and PACF enable the determination of whether the series is stationary or not. Second, different patterns of ACF and PACF and the associated correlograms will yield several ARMA processes, such as AR(*1*), AR(*2*), MA(*1*), MA(*2*), ARMA (*1,1*), ARMA (*1,2*) and so on. Since each of these stochastic processes exhibits typical pattern of ACF and PACF, if the time series under study fits one of these patterns, one can identify the time series with that process. However, one has to apply diagnostic tests to find out if the chosen ARIMA model is reasonably accurate.

- **Estimation**

Once the appropriate values of *p* and *q* have been identified, the next step is to estimate the parameters of the autoregressive and moving average terms included in the model. Sometimes this calculation can be done by simple least squares, but sometimes one will have to resort to non linear (in parameter) estimation methods.

- **Diagnostic checking**

Once the parameters have been estimated, the chosen model is checked if it fits the data reasonably well, because ARIMA models can yield several values of p and q and it is possible that another ARIMA model may yield better estimate of parameters. One easy test of the identified model is to examine if the residuals estimated from these models have white noise; if they have, one can accept the particular fit; otherwise the process has to be done all over again. An overall check of model adequacy is provided by the Ljung-Box Q statistic.

- **Forecasting**

One of the reasons for the popularity of the ARIMA modeling is its success in forecasting, particularly, short-term forecasts. The estimated tentative model can be used to forecast for one period or several periods into the future. Equally important are the assumptions on which the forecasts are based

RESULTS AND DISCUSSIONS

Growth Rate in Vegetable Crops in Haveri District

The growth of area under vegetables in the Haveri district revealed that green chilli recorded the highest growth rate among all the selected vegetable crops during the study period. Likewise, in terms of production green chilli was found

to have the highest growth rate among the other vegetables. Remarkably growth rate in tomato productivity stood far ahead of all other vegetable crops in the study area. Compound growth rate in productivity under tomato, cabbage and green chilli were positive, even though tomato recorded the highest growth rate of about 3.42 per cent. This indicated that the growth of vegetable crops in Haveri was area-led in green chilli while productivity-led growth in tomato. It further indicated that farmers used high yielding variety and other input packages in tomato production compared to other vegetables during the study period. These results are in line with Reddy and Samaya (2012), who studied the growth in area, production, productivity and export of India coffee for the period of 1990-91 to 2009-10.

Table 1: **Compound Growth Rate of AREA, Production and Productivity of Selected Vegetable Crops in Haveri District (Period: 2005-06 to 2015-16)**

Sl. No	Crops	Area (%)	R^2	Production (%)	R^2	Productivity (%)	R^2
1	**Tomato**	6.46*	0.717	10.09*	0.611	3.42***	0.330
2	**Cabbage**	8.91*	0.759	10.49*	0.874	1.45***	0.305
3	**Green chilli**	10.78*	0.648	13.07*	0.603	2.07^{NS}	0.147
4	**Brinjal**	6.39**	0.484	5.22**	0.383	-1.10^{NS}	0.072

Note: *significant at 1 per cent level, **significant at 5 per cent, ***significant at 10 per cent and NS – Non significant

Projected Demand for Vegetable Seeds

Over the years from 2005-06, the actual demand of tomato seeds was 337.98 kgs (Table 1). Further, the results showed that the demand of tomato seeds during 2015-16 was 577.35 kgs. Thus, the demand of tomato seeds in Haveri district was increased and it was forecasted till 2020-21. The demand forecasted for tomato seeds in Haveri district show that demand would increase at the rate of 3.85 per cent per annum. The demand for cabbage seeds in the Haveri district during the period of 2005-06 was 251.91 kgs and increased over the last decade to 559.41 during 2015-16. In 2020-21 the forecasted demand would be 663.95 kgs, growing at a rate of 3.49 per cent per annum during the study period. The demand for green chilli seed was increasing at the rate of 5.59 per cent per annum over the last five years and it was observed that during 2020-21 the demand would be 1986.71 kgs. Similarly, in case of brinjal crop the demand of seed had also increased over the years at the rate of 1.68 per cent per annum and about 408.77 kgs of brinjal seed would be required during the year 2020-21. Similar result was found in Mangala (2014).

CONCLUSIONS

The results of study showed that in Haveri district, green chilli recorded the highest growth rate among all the selected vegetable crops. Projected demand for all the selected vegetables in Haveri district indicated an increasing demand and growth rate ranges from 1.68 to 5.35 per cent. Highest growth was found in green chilli. It could be suggested that vegetable seed companies should develop seeds with which could have consistency in harvest across different stages. It was also found that some of the vegetable hybrids which have good market tended to have low yield compared to hybrids which had less market. Therefore, seed companies have to promote hybrids which have characteristics of both high yielding and high marketability. General good agriculture practices like stacking, timely weeding, etc may bring improvement in yield. Hence, GAP are to be promoted along with promotion of hybrids by respective companies.

Table 2: Projected Demand for Selected Vegetables Seeds in Haveri District

Sl. No	Crops	Demand (kg) 2015-16	Demand During the Years (kg)					Average annual growth rate
			2016-17	2017-18	2018-19	2019-20	2020-21	
1	**Tomato**	577.35	602.66	626.35	650.04	673.73	697.42	3.58
2	**Cabbage**	559.41	580.32	601.23	622.14	643.05	663.95	3.49
3	**Green chilli**	1,513.54	1,616.54	1,709.08	1,801.63	1,894.17	1,986.71	5.59
4	**Brinjal**	376.05	382.59	389.14	395.68	402.23	408.77	1.68

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